AFRL-VS-TR-2002-1647

STRATOSPHERIC LASER PROPAGATION

Robert R. Beland

University of Colorado
Campus Box 19 (Boulder County)
Boulder, CO 80309-0019

October 2002

Final Report

AIR FORCE RESEARCH LABORATORY
Space Vehicles Directorate
29 Randolph Road
AIR FORCE MATERIEL COMMAND
HANSCOM AIR FORCE BASE MA 01731-3010

"This technical report has been reviewed and is approved for publication"

Robert R. Beland
Contract Manager

Robert R. Beland, Chief
Tactical Environmental Support Branch

This report has been reviewed by the ESC Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS).

Qualified requestors may obtain additional copies from the Defense Technical Information Center (DTIC). All others should apply to the National Technical Information Service (NTIS).

If your address has changed, if you wish to be removed from the mailing list, or if the addressee is no longer employed by your organization, please notify AFRL/VSIM, 29 Randolph Road, Hanscom AFB MA 01731-3010. This will assist us in maintaining a current mailing list.

Do not return copies of this report unless contractual obligations or notices on a specific document require that it be returned.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-01-0188

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
30-Oct-2002	Scientific Final	Feb 95 - Sep 97

4. TITLE AND SUBTITLE

Stratospheric Laser Propagation

5a. CONTRACT NUMBER
F19628-94-C-0137

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
62101F

6. AUTHORS
Robert R. Beland

5d. PROJECT NUMBER
ABLM

5e. TASK NUMBER
GE

5f. WORK UNIT NUMBER
AA

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The Regents of the University of Colorado
Campus BOX 19 (Boulder County)
Boulder, CO 80309-0019

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Research Laboratory/VSBL
29 Randolph Rd.
Hanscom AFB, MA 01737-3010

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
AFRL-VS-TR-2002-1647

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release; Distribution Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The University of Colorado simulated the evolution of the two-point coherence function of a plane wave propagating through globally intermittent turbulence. The specific parameters of the probability-density function used were taken from stratospheric experiments. The contractor found that including the large-scale variability of the inner scale requires to carefully define the non-intermittent case. The results show that the coherence of propagation through intermittency, which is known to be strictly larger than the coherence through a medium with the average of the structure function, becomes practically smaller than the coherence through the medium described by a structure function with average parameters. The phenomenon was explained theoretically.

15. SUBJECT TERMS
optical turbulence
wave propagation
wave optics

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Robert R. Beland
UNCLASS	UNCLASS	UNCLASS	SAR	2	19B. TELEPHONE NUMBER *(Include area code)* 871-377-3667

STRATOSPHERIC LASER PROPAGATION – FINAL REPORT

The original contract called for a three year effort and had three Tasks: (1) Correlation and Spectrum of Intensity Through Intermittent Media; (2) Coherence and Intensity Correlation Through Anisotropic and Intermittent Random Medium; and (3) Two-Frequency Correlations of Field and Intensity Propagating in Intermittent and Anisotropic Random Medium. The work began on 19 Sep 1995 and was intended to end on 19 Sep 1998, however, only 68% of the funding was achieved and the contract was descoped on 11 Feb 1998. The contractor fulfilled his Final Report requirement by submitting a Journal Article entitled, "Clarifying the Concepts of Wave Propagation Through Intermittent Media", as the Final Report. However, a mis-communication between the contractor (University of Colorado) and the government occurred and the report was published as Scientific Report No. 4. A Final Report is required to retire an R&D case file and, since the contractor already satisfied their reporting requirements by delivering four reports, this summary is being produced to satisfy the Final Report requirements.

ACCOMPLISHMENTS

From the contract SOW, the following research was accomplished:

TASK 1. Correlation and Spectrum of Intensity Through Intermittent Media.

SUBTASK 1.1. 100% completed.
Derive expressions and partial differential equations for propagation through intermittently random, layered media. Obtain analytical simplifications of the offerer's exact theory according to the anticipated scales of the medium.

SUBTASK 1.2. 100% completed.
Compute the full coverage of intensity correlation, spectrum, and scintillation index of spherical wave propagation in intermittently random medium. Obtain a numerical solution of the governing equations and integral evaluations associated with perturbation theory. Idealized models for the medium will be used for validations.

SUBTASK 1.3. 100% completed.
Parameterize in-situ balloon and aircraft data to obtain a model for the statistics of the average, variance, and scales of the refractive index. The techniques are: Conditional sampling for local stationarity, matching higher order structure functions, compound-Poisson model, and wavelet transforms.

TASK 2. Coherence and Intensity Correlation Through An-isotropic and Intermittent Random Medium.

SUBTASK 2.1. 80% Completed.
Formulate the propagation of the coherence function through an-isotropic, intermittent, random medium. Imaging and adaptive optics are second-moment (coherence) problems. Derive integral-differential equations for the propagation through an-isotropic media, and perturbation solutions for weak or strong anisotropy. Special attention will be given to the imaging configuration and for statistics that can be provided reliably by the ABLEX/ACE data. Inversion algorithms to find the parameters of the medium will also be considered.